

Project Lead



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# Operational Probabilistic Tools for Solar Uncertainty (OPTSUN)

SETO Workshop on Solar Forecasting  
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# EPRI OPTSUN Project – Three Workstreams

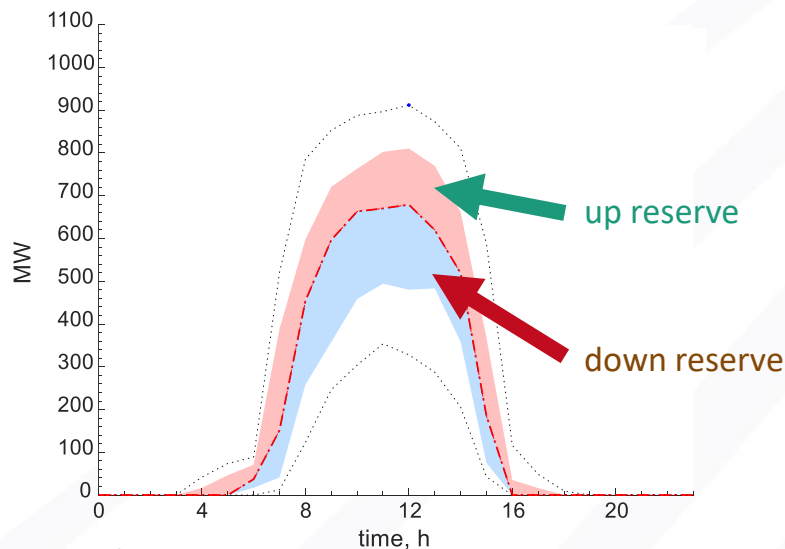
- **Forecasting:** develop and deliver probabilistic forecasts with targeted improvements
- **Design:** identify advanced methods for managing uncertainty based on results from advanced scheduling tools
- **Demonstration:** develop and demonstrate a scheduling management platform (SMP) to integrate probabilistic forecasts and scheduling decisions in a modular and customizable manner



# Use of Probabilistic Forecasts in Operations

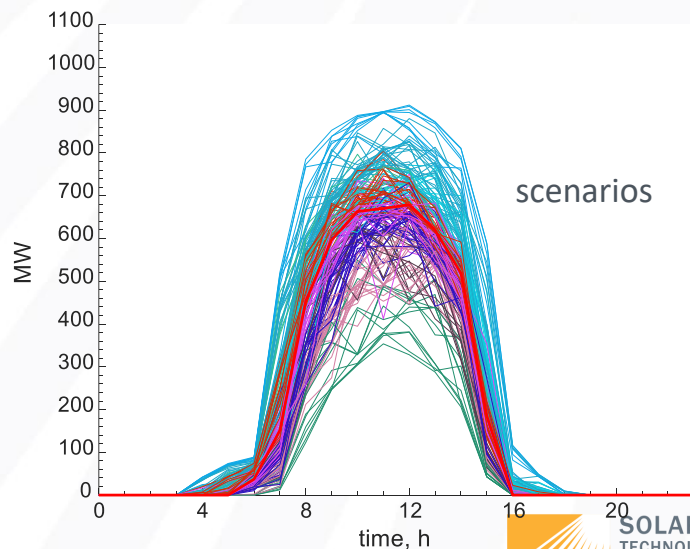
## Use #1: Dynamic Reserve Requirements

- Set operating reserves based on probabilistic forecasts – different methods can be used



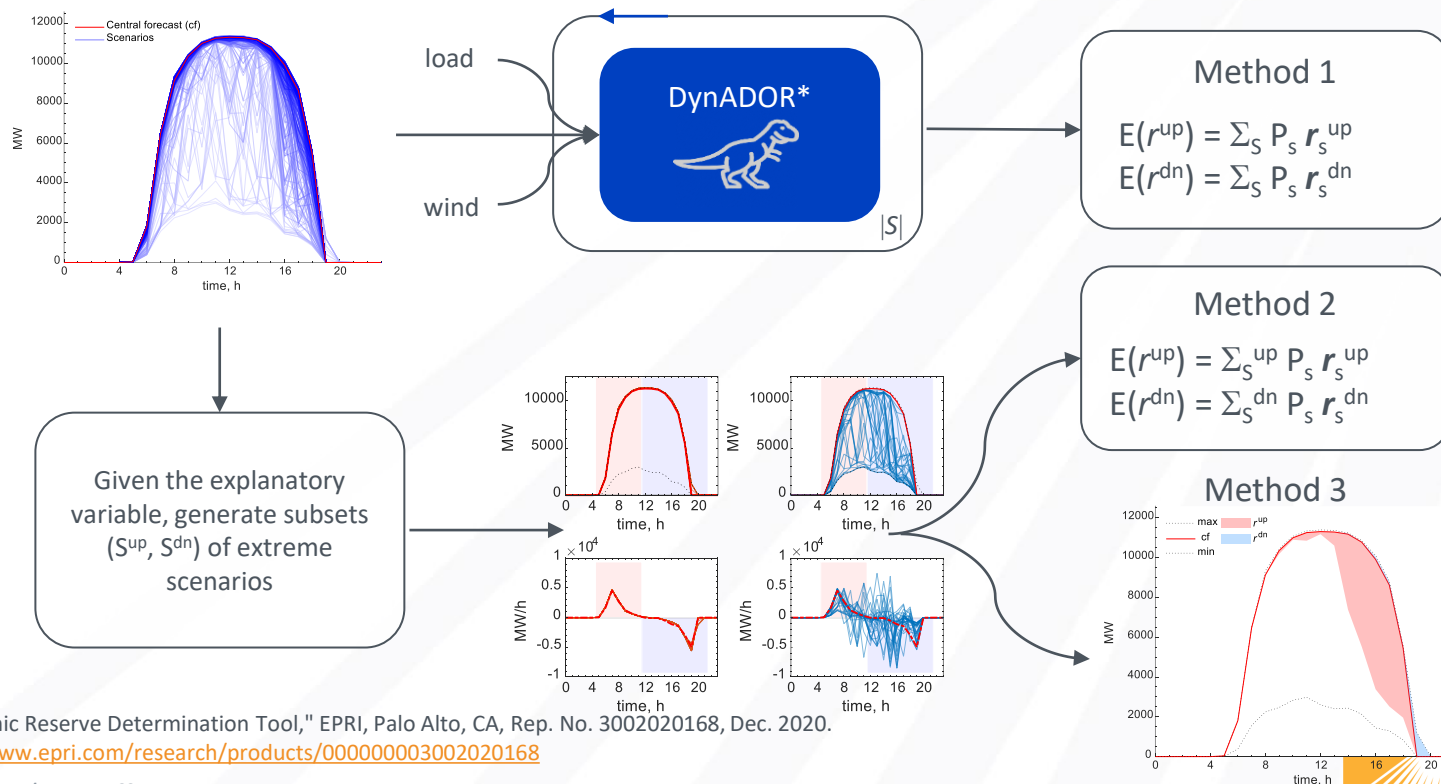
## Use #2: Scenario Generation for UC

- Transform probabilistic info into scenarios, which can be used in a UC model to allow for stochastic UC



# Probabilistic Scenarios to Reserve Requirements

- From scenarios to reserve requirements

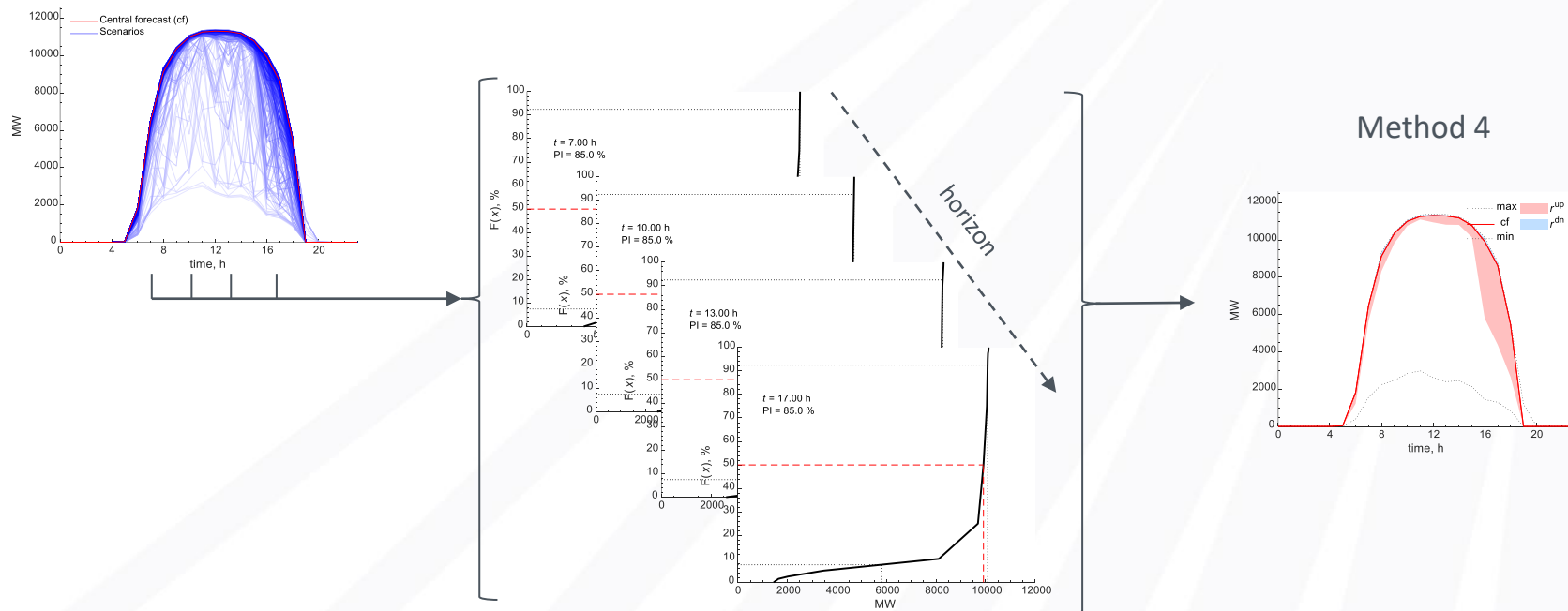


\* "Dynamic Reserve Determination Tool," EPRI, Palo Alto, CA, Rep. No. 3002020168, Dec. 2020.

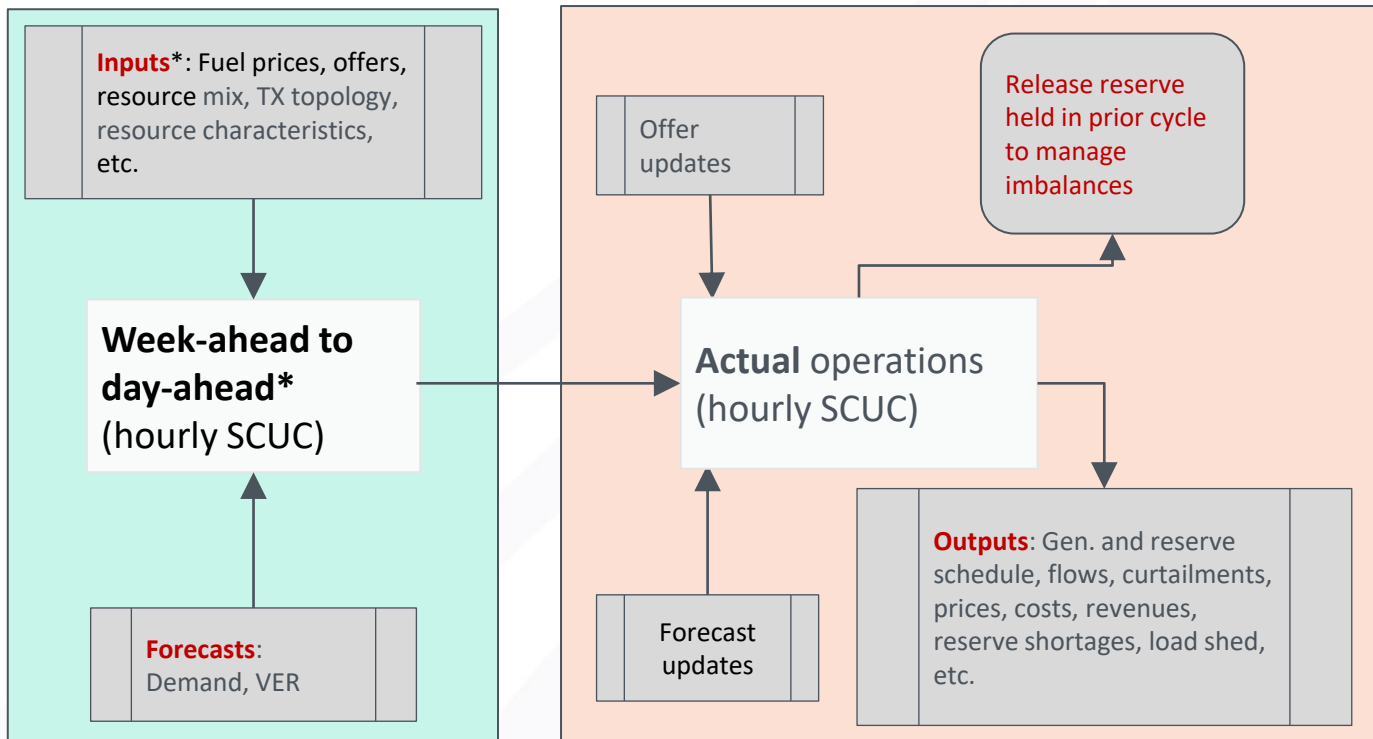
<https://www.epri.com/research/products/000000003002020168>

# Probabilistic Scenarios to Reserve Requirements

- From scenarios to reserve requirements



# Utility Operational Simulations



Note: FESTIV tool used for Hawaiian Electric

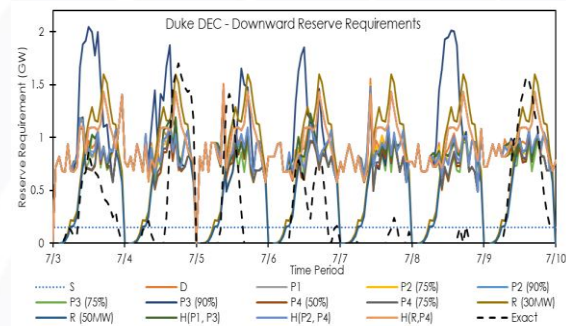
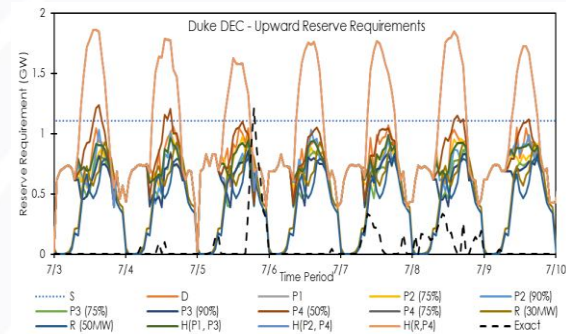
\*SCUC is run at 7AM on the current operating day due to less stressed conditions from midnight – 7am (ISOs/RTOs typically run their DAM at 11AM on the previous operating day or midnight), and run to end of 7 days out



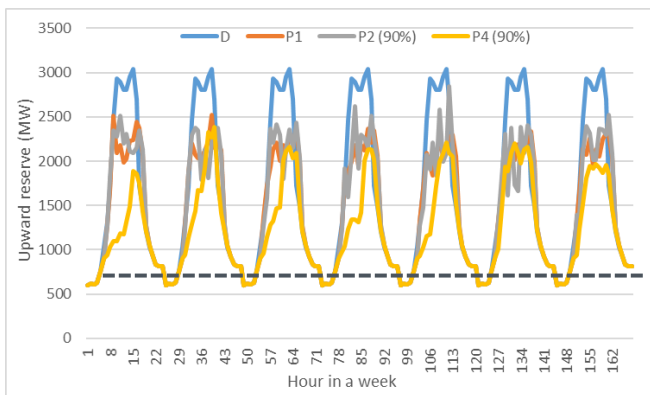
# Preliminary Observations – Duke and Southern

- 1) S: static
- 2) D: deterministic
- 3) PX: probabilistic (methods 1-4)
- 4) R: risk-based
- 5) H: hybrid

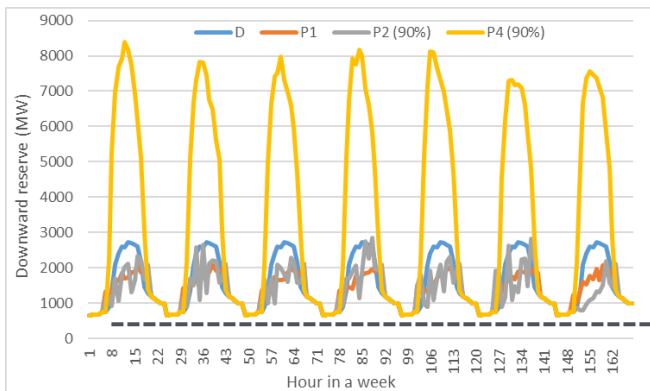
- Hybrid methods outperform other methods in terms of savings and cost reductions
- Impact on system operation - Duke:
  - Upward reserve price is zero in most intervals indicating that there is more than enough inherent reserve in the system
  - Large amounts of flexible resources (CT and PSH) provide upward reserve at zero price (~98.6%)
  - Small cost difference between the cases
- Impact on system operations - Southern:
  - Reduced startups (1.5% - 3%)
  - Function of system fleet and operating thresholds (e.g., load, VRES, etc.)
  - Comparable overall operating costs w.r.t. base case, but lower risk
  - Reduced number of reserve violations



# Example results – more to come!



Upward reserves



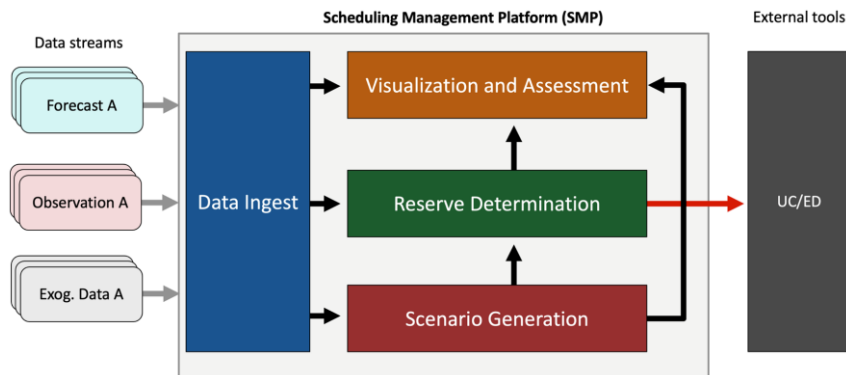
Downward reserves options

Case		Total Production Cost (\$)	Startup Cost (\$)
Dynamic Deterministic		79.04 M	624.7 k
Prob.	P1	78.84 M (↓0.25%)	612.0 k (↓2%)
	P2 (90%)	78.77 M (↓0.33%)	567.0 k (↓11%)
	P4 (90%)	80.80 M (↑2.23%)	1330.0 k (↑113%)

- Some potential benefit from the methods, also expect risk can be addressed more efficiently
- Hybrid methods combining best of different options are being investigated



# Software Tool to Support Integration with Operations



## Scheduling Management Platform

Operations View Historical Performance

### Settings

#### Reserve Method

- ☒ Prediction Interval
- ☐ Extreme Scenario Bounds

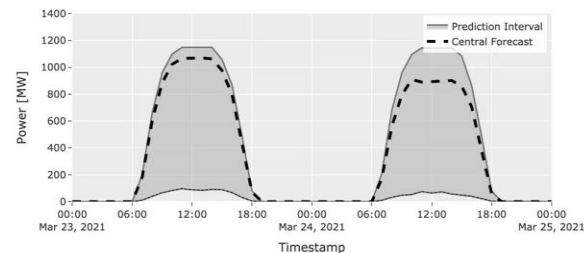
#### Prediction Interval



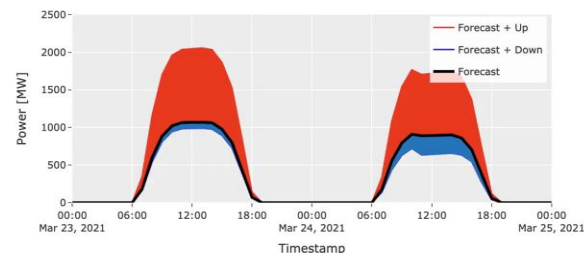
#### Robustness (Extreme Bounds)



### Prediction Interval: PI = 90%



### Forecasts with Reserves



Currently working with participating utilities to refine the platform

- Reserve requirements for different risk preferences and methods
- Scenario generation for UC
- Link to unit commitment/economic dispatch
- Visualize and assess forecasts and reserves

# Overall Conclusions and Final Steps in Project

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- Probabilistic forecasts are being delivered to multiple utilities/ISOs
  - Improved underlying methods, tuned to utility needs
  - Continuing to evaluate and will use Solar Forecast Arbiter in summer
- Methods to use forecasts being investigated for a few regions
  - Hybrid methods are more likely to show value
  - Identifying conditions when benefits are greatest and develop guidelines
  - Examine use directly in scheduling
- Online tool to ingest, analyze and evaluate forecasts
  - Provide means to employ the methods developed
  - Open-source tool coming at end of year

# Questions?

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## Project Lead

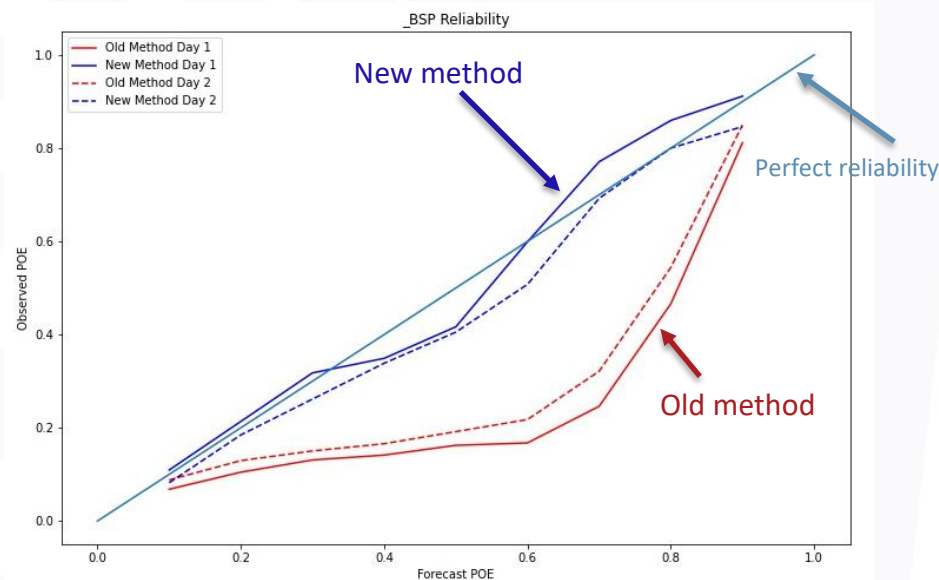


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# Probabilistic Solar Forecast Improvements

- Focusing on horizons relevant to operations (~1-hour to 1-week ahead)
- Machine Learning based approach using gradient-boosted decision tree methods
- Methodology resulted in improved reliability of probabilistic forecasts compared with quantile regression



# Identifying periods to study in more detail

## Representative Days

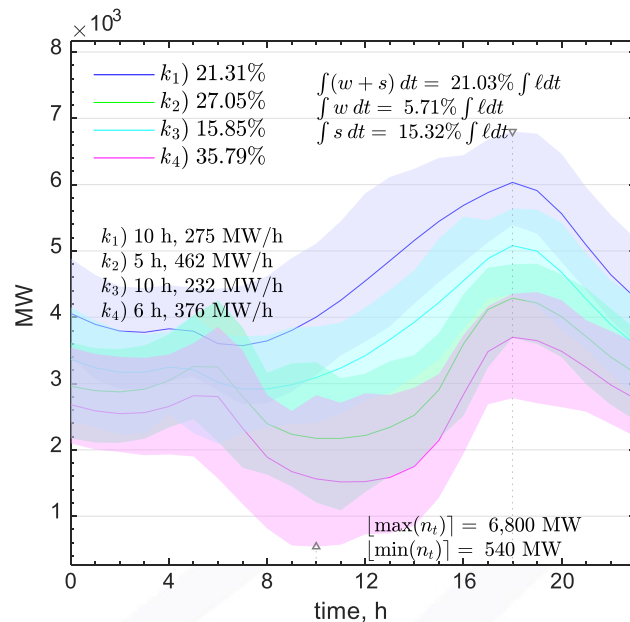


Figure showing Days into four clusters with percentage of membership

## Extreme Days

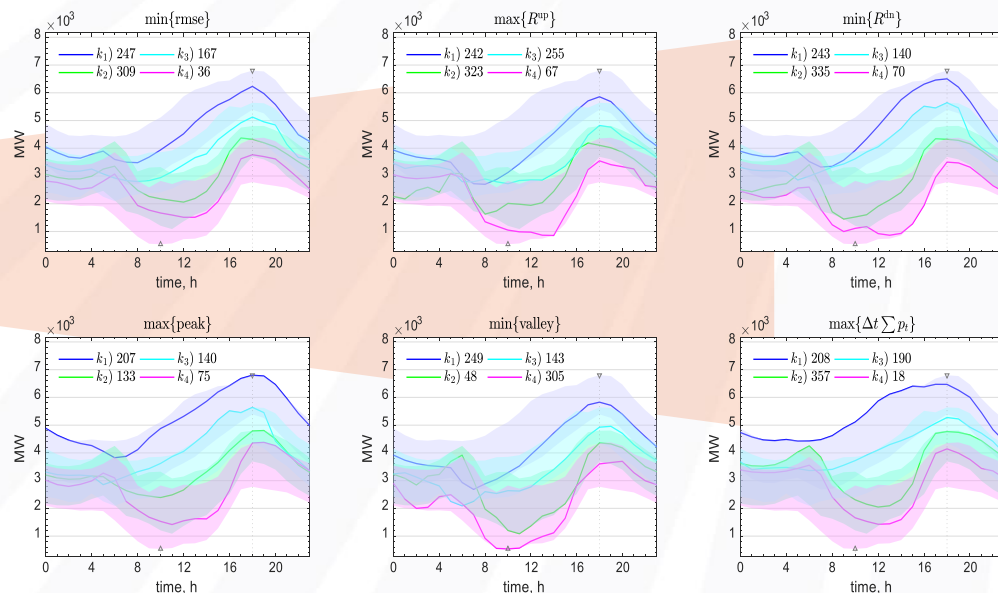


Figure showing Extreme days with respect to a desired feature